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Aryabhatta Centre for Nanoscience & Nanotechnology
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SYNOPSIS

Biosynthesis of Metal and Oxide Nanoparticles: Their Anti-microbial Activity and Cytotoxicity Assay

For the

Ph.D. (*Nano Science & Technology*) Registration

By

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Under the supervision of

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Title of the Research Proposal: **Biosynthesis of Metal and Oxide Nanoparticles: Their Antimicrobial Activity and Cytotoxicity Assay**

Name of the Candidate: ***Priti Kumari***

1. Introduction

Over the past few years, the scientific and engineering communities have been witnessing an impressing progress in the field of nanoscience and nanotechnology. Nanoscience is inherently multidisciplinary: it transcends the conventional boundaries between physics, chemistry, biology, mathematics, materials science, information technology, and many more while Nanotechnology is not confined only to one industry or market. Rather, it is an enabling set of technologies that cross all industrial sectors and scientific disciplines. Probably uniquely, it is classified by the size and shape of the materials being developed and used, not by the processes being used or products being produced. It ensures to deliver novel products and processes or enhance the performance of existing ones across sectors. They include interventions in a range of areas like: water, energy, electronics, healthcare, medicine, agriculture, environment, cosmetics and many more that could enable solutions to several development related problems especially in developing countries. Besides, several industrial sectors like: pharmaceuticals, biotechnology, electronics, communications, civil, automobiles, textiles, chemical, *etc.* appear poised to gain a lot from nanotechnology applications. Nanotechnology provides the ability to engineer the properties of materials by controlling their shape, size and this has driven research towards a multitude of potential uses of nanomaterials. There are several synthesis procedures for the preparation of ultrafine metal, oxide and/or chalcogenide nanoparticles such as extensive ball milling, chemical, hydrothermal, flame combustion, emulsion precipitation, forming materials around/within templates, growth of secondary materials on a crystalline lattice in which the lattice parameter do not match (strained-layer growth), *etc.* All these procedures have their own advantages and disadvantages.

It is known that there are two approaches for synthesis of NPs: top-down and bottom-up approach. Top-down approach generally leads to imperfections of the surface structure. Such imperfections have significant impact on physical properties and surface chemistry of nanoparticles (abbreviated hereafter as NPs) while bottom-up approach is widely considered as a better approach because it has better efficiency, lesser defects and yields more homogeneous chemical composition. Further, biological entities and inorganic materials have been in constant touch with each other ever since the inception of life on earth. Due to this regular interaction, life could sustain on this planet with a well-organized deposit of minerals. Living cells are the best known examples of machines that operate at the nano-level and perform a number of jobs ranging from generation of energy to extraction of targeted materials with very high efficiency. Recent research into the interaction between inorganic substances and biological systems has highlighted their potential application for the production of nanomaterials with interesting technological properties. This has emerged as an upcoming field called as nanobiotechnology. Also, the development of ecologically-benign, 'green' synthesis protocols is in line with the recent RoHS and WEEE legislation stipulated by the EU. It is possible to fabricate of different kind of nanomaterials (metals, oxides, sulfides, *etc.*) with the help of plants, fruits/fruit juice, food beneficiaries, microbes, fungi, animal, *etc.* using nanobiotechnological approach. Therefore, such biosynthetic methods are low-cost and truly green approach.

Accordingly, in the proposed work, different metal (Ag) and oxide (ZnO) NPs shall be prepared from nanobiotechnology approaches using different plants and plant parts which are having proven medicinal properties especially in skin care. The prepared NPs shall be characterized using X-ray diffraction, Transmission electron microscope, UV-Vis and infrared spectroscopy. Also, an effort shall be made to study their dose/concentration dependent effect on antimicrobial activity and cytotoxicity assay.

2. Main objectives of the proposed research work

In the proposed work, metal (Ag) and oxide (ZnO) nanoparticles will be prepared through bionanotechnology route, in-line with RoHS guidelines. The prepared NPs will be characterized by their structural, microstructural, optical, thermal and electrical studies. Also, their dose/concentration dependent effect on anti-microbial and cytotoxicity assays will be

made to ascertain their potential applications in the area of agriculture and biomedical sciences.

3. Methodology

➢ Biosynthesis of Nanoparticles

Biosynthesis of different nanoparticles of metal (Ag) and oxide (ZnO) will be prepared from the plants and/or plant's parts having some medicinal values using high purity (AR/GR grade) water soluble intended metal salts. Also, effort shall be made to optimize the preparation/medium conditions such as salt concentration, reducing agents, incubation time, temperature, *etc.* in order to enhance the quality and yield of NPs.

➢ Characterizations

- **Structural and Microstructural**

The X-ray diffraction of all the prepared NPs will be done at room temperature using an X-ray diffarctometer over a wide range of Bragg angle. This study will provide the quality and structural information of the NPs and their unit cell parameters. The apparent particle sizes and lattice strain of the fabricated NPs will be estimated using the Williamson and Hall approach. The shape, sizes and morophology of the prepared NPs will be recorded using a transmission electron microscope. This study enables to find the structure-properties relationship of the fabricated NPs.

- **Optical**

The absorption spectrum of all the prepared NPs will be obtained by a UV-visible spectrophotometer. This technique shall also be utilized to monitor/decide the completion of biochemical reactions and the formations of the desired NPs. IR spectroscopy study shall also be carried out to see different modes (vibrations) and surface functional group attached, if any, present in the prepared NPs.

➢ Anti-microbial activity and cytotoxicity assay

The biosynthesized NPs will be investigated for potential anti-microbial and cytotoxic effect on cell lines. The anti- microbial activity will be determined by zone inhibition study on Luria broth-agar plates inoculated with different microbial species. The cytotoxic effect on cell lines will be determined by MTT/WST-1 assay. Briefly, $1x10^5$ cells/well will be treated with or without increasing concentration of NPs for 12-24 h

with appropriate vehicle control. Post-treatment cell viability will be determined by adding MTT or Cell proliferation reagent (WST-1) followed by addition of solubilisation buffer to dissolve the formazan crystals as described previously. The A_{570} nm or $A_{450-655}$ nm data obtained from ELISA reader will be plotted to determine the IC50 values. Further characterization of apoptosis markers on cell lines such as Annexin V and DNA fragmentation assay (Tunnel assay) using FACS can be pursued if encouraging results are observed by MTT or WST-1.

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Signature of the Candidate

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